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Report of a walkover survey and desk study of the South Beach Landslide, Whitehaven, Cumbria

Physical Hazards Programme

Internal Report IR/07/002

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Report of a walkover survey and desk study of the South Beach Landslide, Whitehaven, Cumbria

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Keywords

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The South Beach Landslide (Photo: BGS, 03/01/07).

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Foreword

This report describes a walkover survey and desk study by the British Geological Survey to assess the geological properties of a landslide at South Beach, Whitehaven, Cumbria, which resulted in a fatality on the 1st January 2007.

Acknowledgements

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1 Introduction

On 1st January 2007 a fatal accident occurred on South Beach close to the south harbour wall at Whitehaven, Cumbria. A 50-year old woman, Caroline Palser of Frizington, was killed by a cliff collapse (News and Star, 2007). On January 2nd 2007, agreements were made between Andrew Gibson (BGS) and Duncan Fyfe (Copeland Borough Council) that BGS staff would visit the site to examine the landslide area. On 3rd January, 2007, British Geological Survey (BGS) staff Gareth Jenkins and Peter Hobbs, accompanied by Duncan Fyfe (Coastal Engineer for CBC) carried out a walkover inspection of the site of the landslide. The purpose of the survey was to gather information about the nature of the landslide and the geological materials comprising it, and to provide assistance to CBC staff in their assessment of the event. At the site a brief meeting occurred with Liam Murphy (CEO, CBC) and Mike Sharrock (Health & Safety Officer, CBC). On completion of the survey on the 3rd January, BGS staff visited the CBC offices, accompanied by Duncan Fyfe, where they also met Vic Emerson (Environmental Health Manager, CBC.).

2 Location

Whitehaven is a harbour town located to the northwest of the Lake District National Park (Figure 1, Figure 2). The South Beach site (hereafter referred to as the site) is a short section of beach immediately to the south of the harbour wall (from NGR 296695 518649 to 296608 518220). The sea cliff in this area is approximately 4 – 5 m high and is backed by a flat area of grass, a small car park, and a slope backed by a cliff that appears to have been quarried (Figure 3). Most of this area appears to have been landscaped, disguising its industrial origin as an area of colliery spoil tipping dating back about 80 years (Whitehaven News, 2007). Immediately to the east of this area are the remains of the Wellington colliery (Wood, 1988), which include the large candlestick chimney [NGR 296775 518235] and Wellington House [NGR 296737 518275] as well as some retaining walls [NGR 296785 518272]. There was some uncertainty at the time of the visit about the precise location of the cliff fall that caused the accident. However, photographic evidence from the News and Star webpage article (News and Star, 2007) identified the location of the fatal landslide [NGR 296749 518380].

Figure 1. Location of Whitehaven, Cumbria, United Kingdom.

Figure 2. Location of January 1st landslide (circled).

Figure 3. Detailed map of South Beach landslide location (circled). [NGR 296749 518380].

3 Sequence of events

This report has not attempted a detailed reconstruction of the events that led to the landslide occurrence. However, it was necessary to establish the main sequence of events in order to determine the likely cause of the landslide. The following information was supplied by Duncan Fyfe (CBC):

- Over the previous 3 years a localised cliff recession of about 5 m was noted.
- During December 2006, cliff falls had been noticed at the site, and fencing and warning signs erected by CBC (exact timing of this not established by this report).
- During the morning of 1st January, 2007 a cliff-fall occurred and a woman (identified as Caroline Palser) was buried by the debris and died at the scene despite attempts to rescue her by her partner and the emergency services.
- Following the incident, a Health & Safety Executive investigation was initiated and a Coroner's report was also initiated.

4 Geology

4.1 PUBLISHED GEOLOGY

The bedrock geology of the site is shown on BGS 1:50 000 Geological Map Sheet 28 (Whitehaven) Bedrock (BGS, 2004a) as Pennine Middle Coal Measures Formation (Pennine Coal Measures Group) of Carboniferous (Westphalian) age (Figure 4). This Formation consists of mudstone, siltstone and sandstone. Superficial deposits are shown on BGS 1:50 000 Geological Map Sheet 28 (Whitehaven) Solid and Drift Edition (BGS 2004b). The map shows superficial deposits to be Raised Beach Deposits of Flandrian (Quaternary) age, overlain by Made Ground (Figure 5).

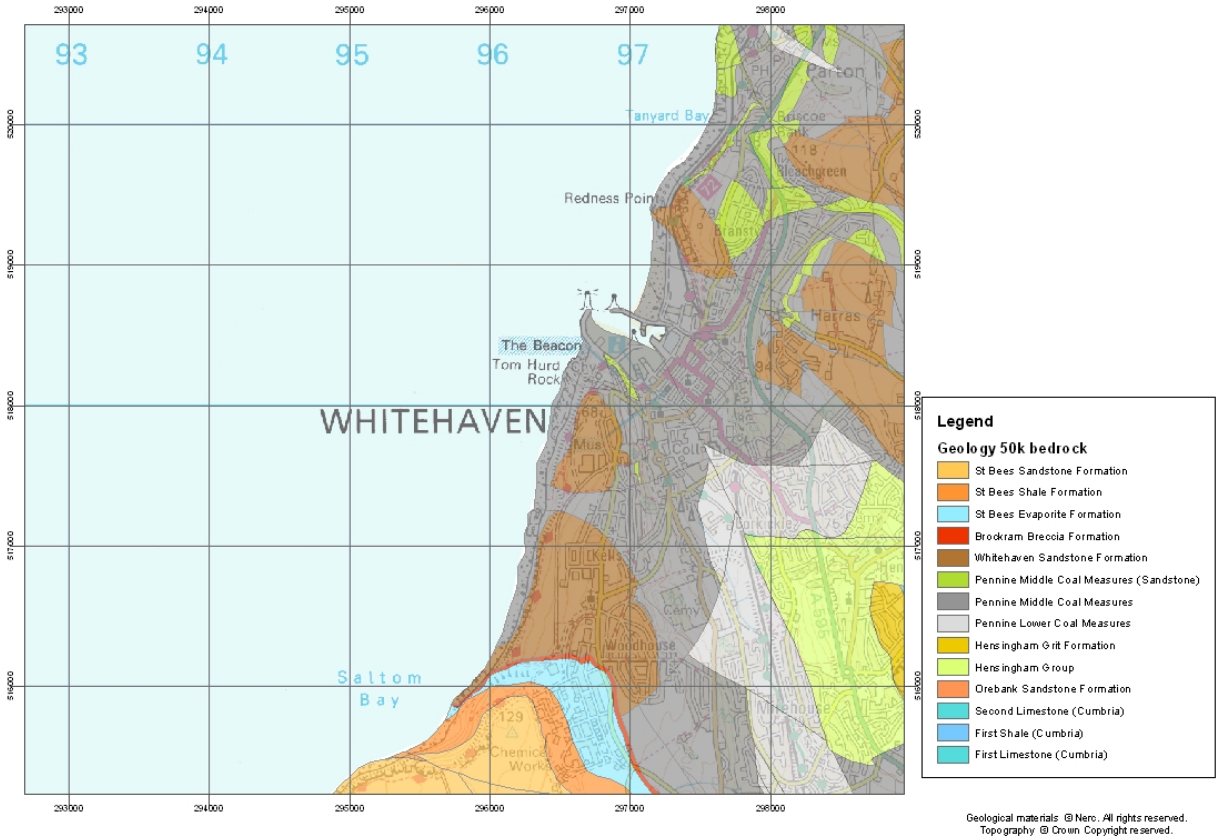

Figure 4. Bedrock Geology of the Whitehaven area. DiGMapGB-50.

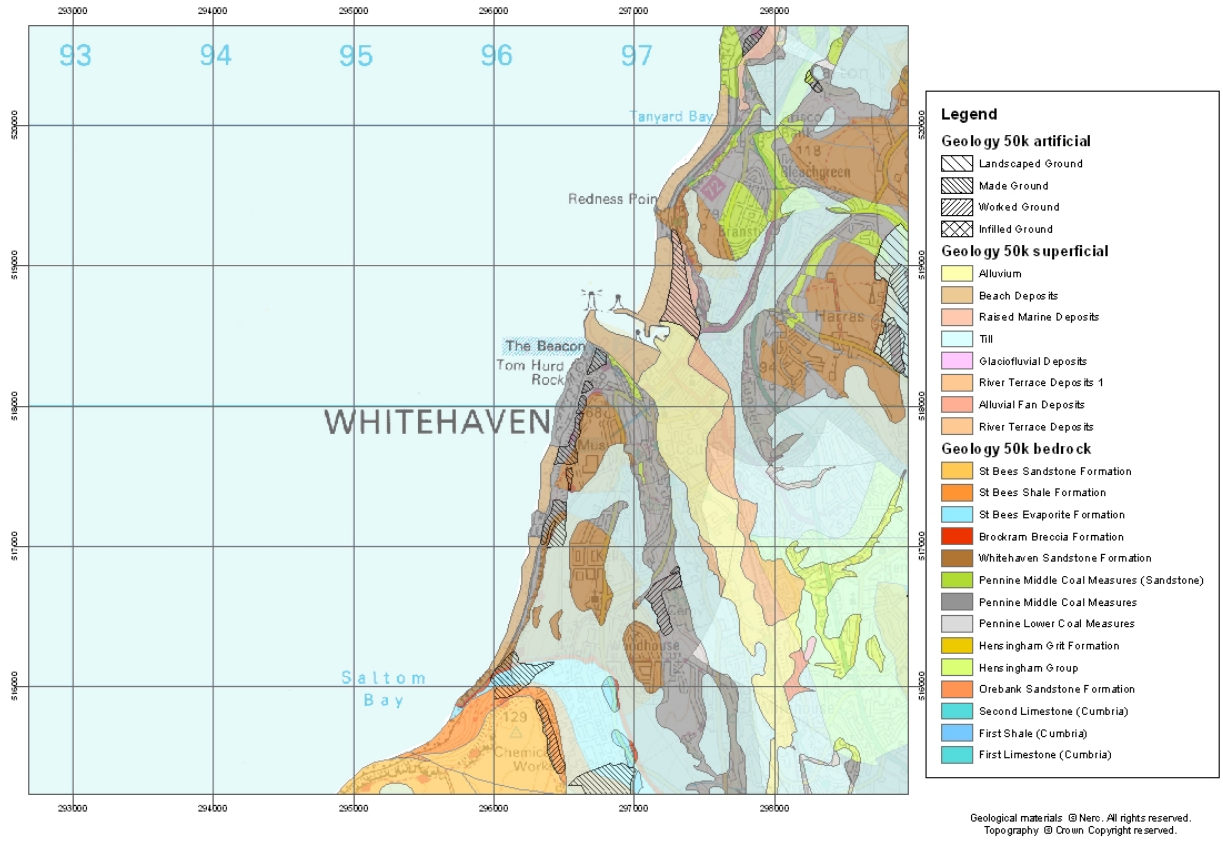

Figure 5. Bedrock, Superficial and Artificial Geology of the Whitehaven area. DiGMapGB-50.

4.2 OBSERVATIONS OF THE GEOLOGY

During the walkover survey to the site, a number of observations were made of the geological succession near the site. The landslide occurred in colliery spoil material, which showed a distinct stratigraphy (layering), with four identifiable units (Figure 6). Brief descriptions of each unit, based upon inspection of material at the cliff face are given in Table 1.

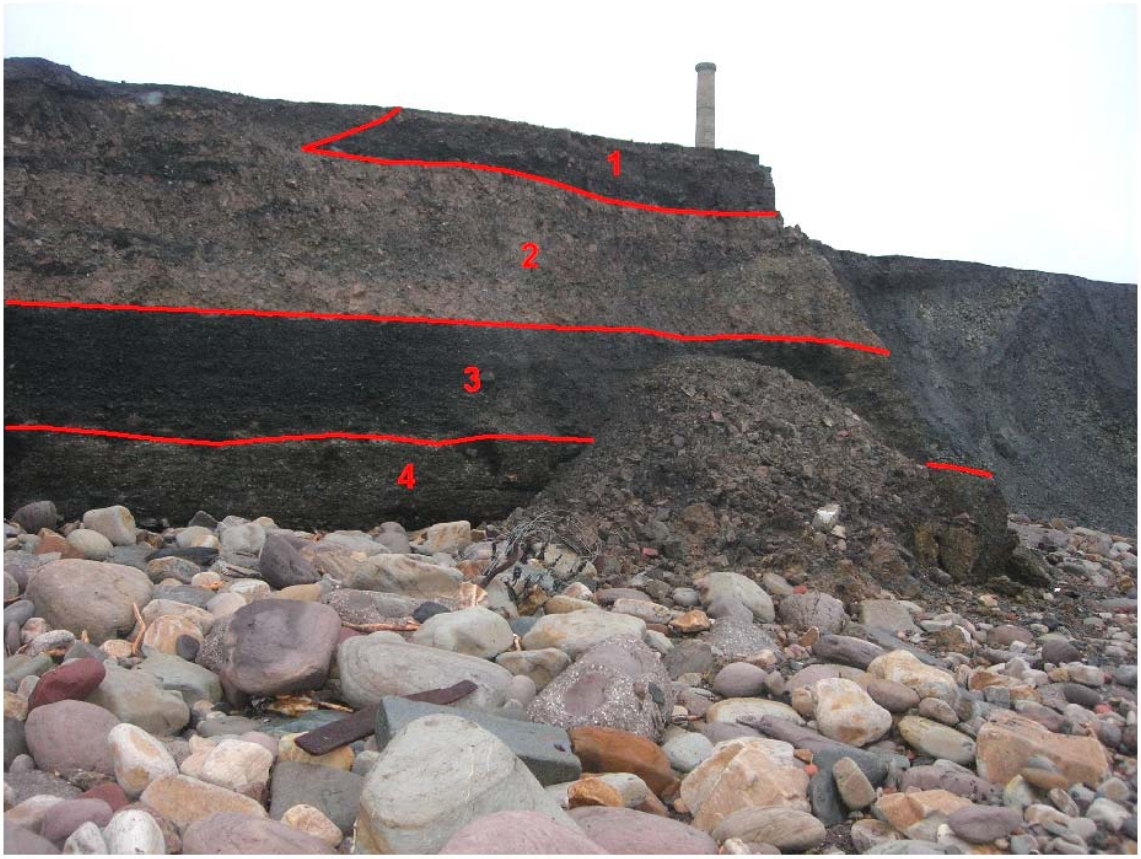

Figure 6. Stratigraphy of colliery spoil at landslide site (Photo: BGS, 03/01/07).

Table 1. Lithological description of cliff stratigraphy shown in Figure 6.

Unit	Field description
1	Dark-grey, up to coarse-gravel size, angular to sub-rounded, slightly stratified [MRCY – Land Raising Mine Fill (Colliery)]
2	Buff/light-grey/brown, loose, clasts of sandstone and colliery debris in gravel/sand/clay matrix. Up to cobble-size (250-300 mm) angular mass, slightly stratified, contains lenses of 1 [MRCY – Land Raising Mine Fill (Colliery)]
3	Dark-grey/black, semi-indurated - loose, coarse gravel-sized (60-80 mm) clasts of coal, shale, slag [MRCY – Land Raising Mine Fill (Colliery)]
4	Dark-grey/greenish-grey/light-grey, loose, coarse gravel-size clasts of shale and colliery debris, undulating stratification (tipped) to south, regular stratification to north [MRCY – Land Raising Mine Fill (Colliery)]

Note. [ ] denotes classification of material to BGS Lexicon Terminology (Ford *et al.*, 2004).

5 Landslide

5.1 SURVEY OBSERVATIONS

The area of the landslide was examined and descriptions made from the beach, with a safe distance maintained away from the cliff face at all times (as deemed by BGS staff). The site of the landslide, as indicated by Mr Fyfe and photographic records, was approximately 25 m south of the harbour wall at NGR 296749 518380. This is shown as Landslide A in Figure 7. The dimensions of the fatal landslide were estimated to be 4.5 m high x 3 m wide x 1.5 m deep (based on observations of the debris and fresh exposure in the cliff). The debris produced a cone-shaped talus feature, some of which had been removed by rescue workers and some eroded by the sea. It is thought that a fresh fall had occurred immediately on top of the fatal slide in the intervening days between the fatality and the site visit, as the debris material observed on the 3rd January looked fresh, and showed little evidence of disturbance, which would have been consistent following the rescue efforts (Figure 10). Therefore some of the debris material observed and described on the 3rd January 2007 is not likely to have been involved in the fatality. The landslide debris was composed of colliery spoil which consisted of loose, multicoloured, grey, dark brown and black, clay, silt, sand, gravel and cobbles which were sub-rounded to angular.

During this survey, a further landslide occurred, at NGR 296742 518372 (Landslide B on Figure 7) and was observed at close hand by BGS staff and Duncan Fyfe. (Figure 8). The landslide was approximately 4 m high x 8 m wide x 0.75 m deep and provided evidence for the style, mechanism, and amount of material involved in failures in the colliery spoil cliff.

A further recent landslide was also examined at NGR 296727 518349 (Landslide C). The landslide was 4 m high x 7 m wide x 1 m deep, and had undercut the concrete path running along the cliff top (Figure 9). This landslide also provided evidence for the style and volume of material involved in failures in the colliery spoil cliff.

The area above the site of the landslide was also examined with particular attention to the grassed and fenced-off area at the cliff top. Although detailed measurements were not recorded, a series of fresh tension cracks were observed immediately to the north of landslide C where the concrete footpath had been undermined by previous landslide activity (Figure 10).

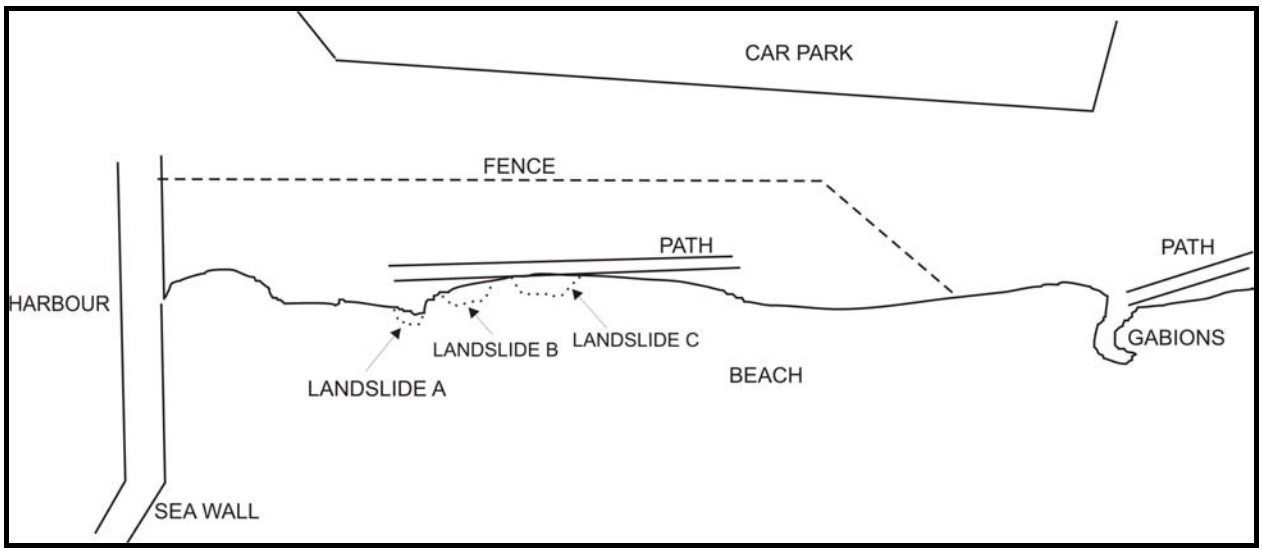

Figure 7. Sketch map (not to scale) showing main features of site (north - left, south - right).

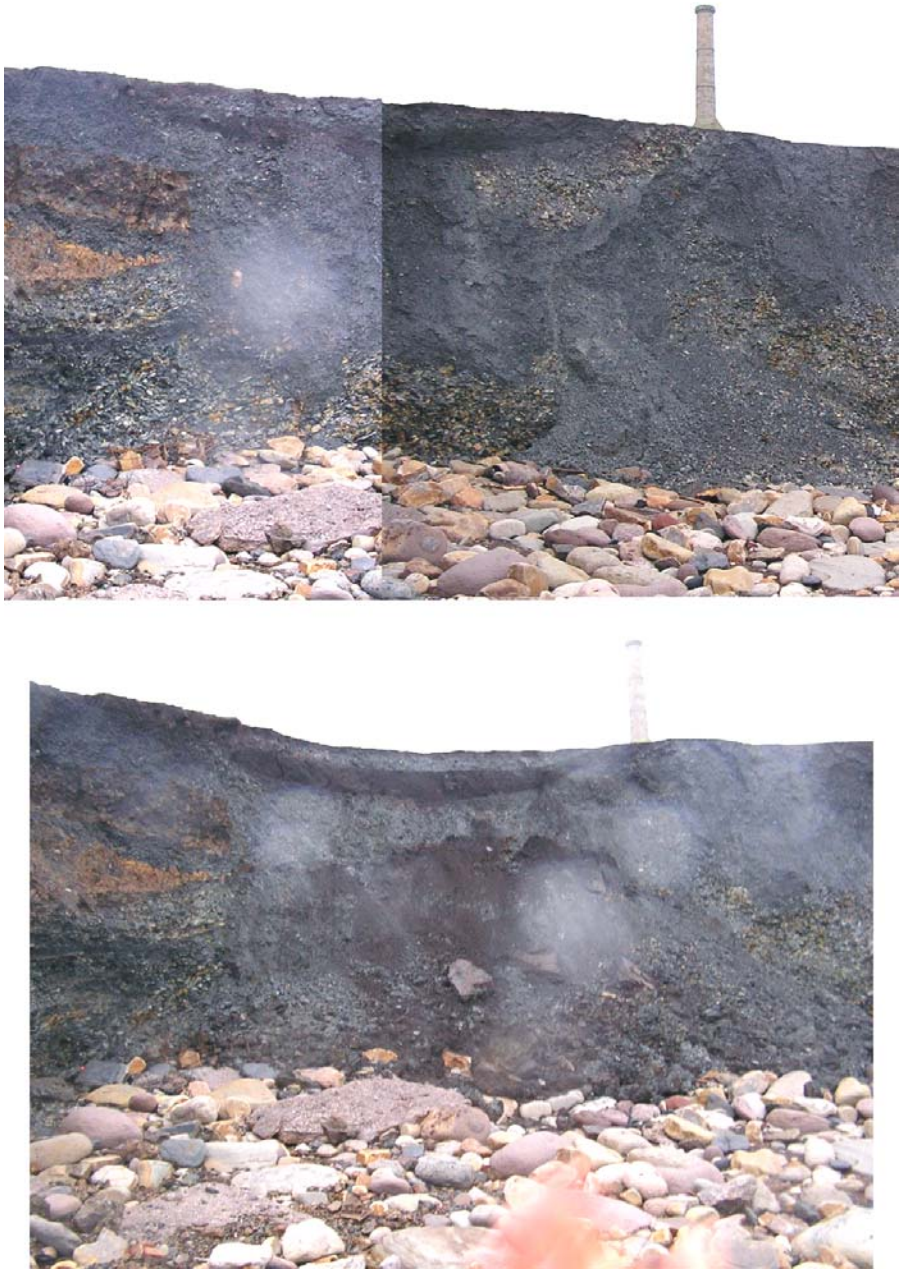

Figure 8. Before and after of Landslide B. Top photograph taken at 14:48, bottom photograph taken at 15:26 (Photo: BGS, 03/01/07).

Figure 9. Landslide C undercutting the concrete coastal footpath at NGR 296727 518349. (Photo: BGS, 03/01/07).

Figure 10. Tension cracks immediately to the north of Landslide C (Photo: BGS, 03/01/07).

5.2 INTERPRETATION

Due to the nature of the material, and the mechanism of landsliding observed in Landslide B on the 3rd January 2007, the landslide can be classified as a debris fall (Figure 11), according to the Varnes Landslide Classification Scheme (Varnes, 1978). Rainfall figures for November and December 2006 were 125 to 150% and 175 to 200% respectively above the 1961-1990 average (Met Office, 2006 & 2007). This high rainfall had saturated the colliery spoil material, increasing the pore water pressure and causing the material to become unstable. The grassed area above the cliff was observed to be flat and therefore deemed likely to provide poor drainage. This, coupled with prolonged heavy rainfall may have lead to the saturation of the spoil material. In addition, high tides and rough seas have eroded the cliff, and created a slope beyond the angle at which the material is stable (angle of repose). It is likely that this removal of support by wave action, coupled with the saturated ground has caused the colliery spoil material to become unstable and fail.

Figure 11. The fatal landslide (Landslide A) at NGR 296749 518380 (Photo: BGS, 03/01/07).

6 Conclusions

A landslide in a cliff of colliery spoil occurred at South Beach, Whitehaven, Cumbria on 1st January, 2007. The landslide resulted in a fatality. It is likely that a combination of high rainfall, high tides and rough seas had resulted in the colliery spoil material to become unstable and fail.

7 Recommendations

It is recommended that further safety measures be implemented at the earliest opportunity due to the fact that the cliff-fall hazard remains ongoing:

7.1 IMMEDIATE SAFETY

Due to the unstable nature of the colliery spoil material; access to the area should be prevented. This involves no public access to the beach, and at least a 5 m fenced buffer zone along the cliff top. Based on observations on the 3rd January 2007 (in particular the failure of Landslide B), it is likely that any future single cliff failure event will result in no more than 1-2 m recession of the cliff top. Constant monitoring of the cliff top is strongly recommended in order to maintain the 5 m buffer.

Signage along the cliff top and in the immediate vicinity of the car park should warn the public of the risk posed by the landslide hazard in the area.

It was also noted during the walkover survey that there was considerable damage to the gabion wall at the southern end of the beach (Figure 12). The unstable gabion baskets present a risk to the public from collapse, and it is recommended that this be remediated.

Figure 12. Damage to gabion wall at southern end of beach [NGR 96696 18300] (Photo: BGS, 03/01/07).

7.2 MEDIUM-TERM MANAGEMENT

In order to manage the site effectively, it is necessary to understand the properties of the heterogeneous colliery spoil material in three dimensions. This would involve detailed geotechnical tests on the spoil material.

7.3 LONG-TERM MANAGEMENT

To more fully alleviate the landslide hazard and risk posed by the colliery spoil material in the longer term, consideration should be given to the extraction and removal of the spoil from the site. Before this could be achieved it would be necessary to establish a number of parameters. The volume of different materials within the spoil material would need to be taken into account, and suitable disposal sites sourced prior to the removal of the material. Due to the origin of the colliery spoil, it is likely that the material will be contaminated. Removal of the spoil would also require a better understanding of the bedrock profile currently covered. This is necessary to calculate how much material there actually is but will also provide an indication of how stable any uncovered bedrock would be. It is well documented (Boggett, *et al.*, 2000) that cliffs formed by the bedrock in this area are unstable. Appropriate design of remediation of this hazard would require an understanding of the geotechnical properties and performance of the cliff section and coastal processes that will affect it.

7.4 RECOMMENDATIONS

In addition to the short to long term actions above, it is recommended that a more detailed site investigation is undertaken before any long-term remedial measures are considered. This would involve the drilling of boreholes and/or a geophysical survey in order to determine the exact location and orientation of the pre-tipped bedrock profile currently obscured by the spoil. A better understanding of the properties and exact distribution of the colliery spoil is also necessary. Coastal processes (past and contemporary) should also be examined to establish the impact upon the current or future coastal section.

NOTE 1: Conclusions and recommendations contained in this report are based solely on a walkover survey, and a brief desk-study. No sub-surface investigations were made.

NOTE 2: Information contained in this report should not be used as a substitute for adequate site investigation.

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Most of the references listed below are held in the Library of the British Geological Survey at Keyworth, Nottingham. Copies of the references may be purchased from the Library subject to the current copyright legislation.

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